

Amendments to the Claims:

Please cancel claims 2439, 2440, and 5166 without prejudice.

This listing of claims will replace all prior versions and listings of claims in the application.

Listing of Claims:

1-2423. (cancelled)

2424. (currently amended): A method of treating a coal formation in situ, comprising:
providing heat from one or more heaters positioned in heater wells to at least a portion of the formation;

allowing the heat to transfer from the one or more heaters to a part of the formation; and
producing a mixture from the formation through one or more production wells, wherein at least about 7 heaters are disposed in the formation for each production well; and

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-wherein the heating is controlled such that the mixture is produced from the formation as a vapor, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 1% by weight, when calculated on an atomic basis, of the condensable hydrocarbons is oxygen ~~and wherein at least about 7 heaters are disposed in the formation for each production well.~~

2425. (currently amended): The method of claim 2424, wherein the one or more heaters comprise at least two heaters, and wherein superposition of heat from at least the two heaters pyrolyzes at least some hydrocarbons ~~within in~~ the part of the formation.

2426. (currently amended): The method of claim 2424, further comprising maintaining a temperature ~~within in~~ the part of the formation ~~within in~~ a pyrolysis temperature range of about 270 °C to about 400 °C.

2427-2429. (cancelled)

2430. (previously presented): The method of claim 2424, wherein at least one of the heaters comprises a natural distributed combustor.

2431. (currently amended): The method of claim 2424, further comprising controlling a pressure and a temperature ~~within~~in at least a majority of the part of the formation, wherein the pressure is controlled as a function of temperature, or the temperature is controlled as a function of pressure.

2432. (currently amended) The method of claim 2424, further comprising controlling the heat such that an average heating rate of the part of the formation is less than about 1 °C per day ~~within~~in a pyrolysis temperature range of about 270 °C to about 400 °C.

2433. (currently amended): The method of claim 2424, wherein providing heat from the one or more heaters to at least the portion of the formation comprises:

heating a selected volume (V) of the coal formation from the one or more heaters, wherein the formation has an average heat capacity (C_v), and wherein the heating pyrolyzes at least some hydrocarbons ~~within~~in the selected volume of the formation; and

wherein heating energy/day (Pwr) provided to the selected volume is equal to or less than $h \cdot V \cdot C_v \cdot \rho_B$, wherein ρ_B is formation bulk density, and wherein an average heating rate of the formation (h) is about 10 °C/day.

2434. (original): The method of claim 2424, wherein allowing the heat to transfer comprises transferring heat substantially by conduction.

2435. (currently amended): The method of claim 2424, wherein allowing the heat to transfer ~~to the part of the formation heats the part of the formation to increase~~increases a thermal conductivity of ~~at least a portion of~~ the part of the formation to greater than about 0.5 W/(m °C).

2436. (original): The method of claim 2424, wherein the produced mixture comprises condensable hydrocarbons having an API gravity of at least about 25°.

2437. (original): The method of claim 2424, wherein the produced mixture comprises condensable hydrocarbons, and wherein about 0.1 % by weight to about 15 % by weight of the condensable hydrocarbons are olefins.

2438. (original): The method of claim 2424, wherein the produced mixture comprises non-condensable hydrocarbons, and wherein a molar ratio of ethene to ethane in the non-condensable hydrocarbons ranges from about 0.001 to about 0.15.

2439. (cancelled)

2440. (cancelled)

2441. (original) The method of claim 2424, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 1% by weight, when calculated on an atomic basis, of the condensable hydrocarbons is sulfur.

2442. (original): The method of claim 2424, wherein the produced mixture comprises condensable hydrocarbons, wherein about 5 % by weight to about 30 % by weight of the condensable hydrocarbons comprise oxygen containing compounds, and wherein the oxygen containing compounds comprise phenols.

2443. (original): The method of claim 2424, wherein the produced mixture comprises condensable hydrocarbons, and wherein greater than about 20 % by weight of the condensable hydrocarbons are aromatic compounds.

2444. (original): The method of claim 2424, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 5 % by weight of the condensable hydrocarbons comprises multi-ring aromatics with more than two rings.

2445. (original): The method of claim 2424, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 0.3 % by weight of the condensable hydrocarbons are asphaltenes.

2446. (original): The method of claim 2424, wherein the produced mixture comprises condensable hydrocarbons, and wherein about 5 % by weight to about 30 % by weight of the condensable hydrocarbons are cycloalkanes.

2447. (previously presented): The method of claim 2424, wherein the produced mixture comprises a non-condensable component, wherein the non-condensable component comprises molecular hydrogen, wherein the molecular hydrogen is greater than about 10 % by volume of the non-condensable component at 25 °C and one atmosphere absolute pressure, and wherein the molecular hydrogen is less than about 80 % by volume of the non-condensable component at 25 °C and one atmosphere absolute pressure.

2448. (original): The method of claim 2424, wherein the produced mixture comprises ammonia, and wherein greater than about 0.05 % by weight of the produced mixture is ammonia.

2449. (original): The method of claim 2424, wherein the produced mixture comprises ammonia, and wherein the ammonia is used to produce fertilizer.

2450-2456. (cancelled)

2457. (previously presented): The method of claim 2424, wherein allowing the heat to transfer increases a permeability of a majority of the part of the formation to greater than about 100 millidarcy.

2458. (previously presented): The method of claim 2424, wherein allowing the heat to transfer increases a permeability of a majority of the part of the formation such that the permeability of the majority of the part is substantially uniform.

2459. (cancelled)

2460. (previously presented): The method of claim 2424, further comprising providing heat from three or more heaters to at least a portion of the formation, wherein three or more of the heaters are located in the formation in a unit of heaters, and wherein the unit of heaters comprises a triangular pattern.

2461. (previously presented): The method of claim 2424, further comprising providing heat from three or more heaters to at least a portion of the formation, wherein three or more of the heaters are located in the formation in a unit of heaters, wherein the unit of heaters comprises a triangular pattern, and wherein a plurality of the units are repeated over an area of the formation to form a repetitive pattern of units.

2462-5149. (cancelled)

5150. (previously presented): The method of claim 2424, wherein the part of the formation comprises a selected section.

5151. (currently amended): The method of claim 2424, wherein allowing the heat is ~~allowed~~ to transfer from one or more of the heaters ~~to at least a portion of the part of the formation to establish~~ establishes a pyrolysis zone in the part of the formation.

5152. (currently amended): The method of claim 2424, wherein allowing the heat is ~~allowed~~ to transfer from one or more of the heaters ~~to at least a portion of the part of the formation to~~

~~establish~~establishes a pyrolysis zone proximate to and/or surrounding at least one of the one or more heaters in the part of the formation.

5153. (previously presented): The method of claim 2424, wherein at least one of the one or more heaters is disposed in an open heater well.

5154. (currently amended): A method of treating a coal formation in situ, comprising:

providing heat from one or more heaters positioned in heater wells to at least a portion of the formation;

allowing the heat to transfer from the one or more heaters to a part of the formation;
controlling the heat such that an average heating rate of the part of the formation is less than about 1 °C per day in a pyrolysis temperature range of about 270 °C to about 400 °C; and

producing a mixture from the formation through one or more production wells, wherein at least about 7 heaters are disposed in the formation for each production well.

5155. (previously presented): The method of claim 5154, wherein the part of the formation comprises a selected section.

5156. (currently amended): The method of claim 5154, wherein allowing the heat ~~is allowed to transfer from one or more of the heaters to at least a portion of the part of the formation to~~ ~~establish~~establishes a pyrolysis zone in the part of the formation.

5157. (currently amended): The method of claim 5154, wherein allowing the heat ~~is allowed to transfer from one or more of the heaters to at least a portion of the part of the formation to~~ ~~establish~~establishes a pyrolysis zone proximate to and/or surrounding at least one of the one or more heaters in the part of the formation.

5158. (previously presented): The method of claim 5154, wherein at least one of the one or more heaters is disposed in an open heater well.

5159. (currently amended): The method of claim 5154, wherein the one or more heaters comprise at least two heaters, and wherein superposition of heat from at least the two heaters pyrolyzes at least some hydrocarbons ~~within~~in the part of the formation.

5160. (currently amended): The method of claim 5154, further comprising maintaining a temperature ~~within~~in the part of the formation ~~within~~in a pyrolysis temperature range of about 270 °C to about 400 °C.

5161. (withdrawn): The method of claim 5154, wherein at least one of the heaters comprises an electrical heater.

5162. (withdrawn): The method of claim 5154, wherein at least one of the heaters comprises a surface burner.

5163. (withdrawn): The method of claim 5154, wherein at least one of the heaters comprises a flameless distributed combustor.

5164. (previously presented): The method of claim 5154, wherein at least one of the heaters comprises a natural distributed combustor.

5165. (currently amended): The method of claim 5154, further comprising controlling a pressure and a temperature ~~within~~in at least a majority of the part of the formation, wherein the pressure is controlled as a function of temperature, or the temperature is controlled as a function of pressure.

5166. (cancelled)

5167. (currently amended): The method of claim 5154, wherein providing heat from the one or more heaters to at least the portion of the formation comprises:

heating a selected volume (V) of the coal formation from the one or more heaters, wherein the formation has an average heat capacity (C_v), and wherein the heating pyrolyzes at least some hydrocarbons ~~within~~in the selected volume of the formation; and

wherein heating energy/day (Pwr) provided to the selected volume is equal to or less than $h*V*C_v*\rho_B$, wherein ρ_B is formation bulk density, and wherein an average heating rate of the formation (h) is about 10 °C/day.

5168. (previously presented): The method of claim 5154, wherein allowing the heat to transfer comprises transferring heat substantially by conduction.

5169. (previously presented): The method of claim 5154, wherein allowing the heat to transfer to the part of the formation heats the part of the formation to increase a thermal conductivity of at least a portion of the part of the formation to greater than about 0.5 W/(m °C).

5170. (previously presented): The method of claim 5154, wherein the produced mixture comprises condensable hydrocarbons having an API gravity of at least about 25°.

5171. (previously presented): The method of claim 5154, wherein the produced mixture comprises condensable hydrocarbons, and wherein about 0.1 % by weight to about 15 % by weight of the condensable hydrocarbons are olefins.

5172. (previously presented): The method of claim 5154, wherein the produced mixture comprises non-condensable hydrocarbons, and wherein a molar ratio of ethene to ethane in the non-condensable hydrocarbons ranges from about 0.001 to about 0.15.

5173. (previously presented) The method of claim 5154, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 1 % by weight, when calculated on an atomic basis, of the condensable hydrocarbons is nitrogen.

5174. (previously presented) The method of claim 5154, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 1 % by weight, when calculated on an atomic basis, of the condensable hydrocarbons is oxygen.

5175. (previously presented) The method of claim 5154, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 1 % by weight, when calculated on an atomic basis, of the condensable hydrocarbons is sulfur.

5176. (previously presented): The method of claim 5154, wherein the produced mixture comprises condensable hydrocarbons, wherein about 5 % by weight to about 30 % by weight of the condensable hydrocarbons comprise oxygen containing compounds, and wherein the oxygen containing compounds comprise phenols.

5177. (previously presented): The method of claim 5154, wherein the produced mixture comprises condensable hydrocarbons, and wherein greater than about 20 % by weight of the condensable hydrocarbons are aromatic compounds.

5178. (previously presented): The method of claim 5154, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 5 % by weight of the condensable hydrocarbons comprises multi-ring aromatics with more than two rings.

5179. (previously presented): The method of claim 5154, wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 0.3 % by weight of the condensable hydrocarbons are asphaltenes.

5180. (previously presented): The method of claim 5154, wherein the produced mixture comprises condensable hydrocarbons, and wherein about 5 % by weight to about 30 % by weight of the condensable hydrocarbons are cycloalkanes.

5181. (previously presented): The method of claim 5154, wherein the produced mixture comprises a non-condensable component, wherein the non-condensable component comprises molecular hydrogen, wherein the molecular hydrogen is greater than about 10 % by volume of the non-condensable component at 25 °C and one atmosphere absolute pressure, and wherein the molecular hydrogen is less than about 80 % by volume of the non-condensable component at 25 °C and one atmosphere absolute pressure.

5182. (previously presented): The method of claim 5154, wherein the produced mixture comprises ammonia, and wherein greater than about 0.05 % by weight of the produced mixture is ammonia.

5183. (previously presented): The method of claim 5154, wherein the produced mixture comprises ammonia, and wherein the ammonia is used to produce fertilizer.

5184. (withdrawn): The method of claim 5154, further comprising controlling a pressure ~~within~~ in at least a majority of the part of the formation, wherein the controlled pressure is at least about 2.0 ~~bar-bars~~ absolute.

5185. (withdrawn): The method of claim 5154, further comprising controlling formation conditions to produce the mixture, wherein a partial pressure of H₂ ~~within-in~~ in the mixture is greater than about 0.5 bar.

5186. (withdrawn): The method of claim 5185, wherein the partial pressure of H₂ ~~within-in~~ in the mixture is measured when the mixture is at a production well.

5187. (withdrawn): The method of claim 5154, further comprising altering a pressure ~~within-in~~ in the formation to inhibit production of hydrocarbons from the formation having carbon numbers greater than about 25.

5188. (withdrawn): The method of claim 5154, further comprising controlling formation conditions by recirculating a portion of hydrogen from the mixture into the formation.

5189. (withdrawn) The method of claim 5154, further comprising:
providing hydrogen (H₂) to the part of the formation to hydrogenate hydrocarbons ~~within~~
in the part of the formation; and
heating a portion of the part of the formation with heat from hydrogenation.

5190. (withdrawn): The method of claim 5154, further comprising:
producing hydrogen and condensable hydrocarbons from the formation; and
hydrogenating a portion of the produced condensable hydrocarbons with at least a portion of the produced hydrogen.

5191. (previously presented): The method of claim 5154, wherein allowing the heat to transfer increases a permeability of a majority of the part of the formation to greater than about 100 millidarcy.

5192. (previously presented): The method of claim 5154, wherein allowing the heat to transfer increases a permeability of a majority of the part of the formation such that the permeability of the majority of the part is substantially uniform.

5193. (withdrawn): The method of claim 5154, wherein the heating is controlled to yield greater than about 60% by weight of condensable hydrocarbons, as measured by Fischer Assay.

5194. (previously presented): The method of claim 5154, further comprising providing heat from three or more heaters to at least a portion of the formation, wherein three or more of the heaters are located in the formation in a unit of heaters, and wherein the unit of heaters comprises a triangular pattern.

5195. (previously presented): The method of claim 5154, further comprising providing heat from three or more heaters to at least a portion of the formation, wherein three or more of the heaters are located in the formation in a unit of heaters, wherein the unit of heaters comprises a triangular pattern, and wherein a plurality of the units are repeated over an area of the formation to form a repetitive pattern of units.

5196. (currently amended): A method of treating a coal formation in situ, comprising:
providing heat from one or more heaters positioned in heater wells to at least a portion of the formation;

allowing the heat to transfer from the one or more heaters to a part of the formation,
wherein at least about 7 heaters are disposed in the formation for each production well; and

producing a mixture from the formation through one or more production wells, wherein the heating is controlled such that substantially all of the mixture is produced from the formation as a ~~vapor, and~~ vapor; and

wherein the produced mixture comprises condensable hydrocarbons, and wherein less than about 1 % by weight, when calculated on an atomic basis, of the condensable hydrocarbons is nitrogen.

~~wherein at least about 7 heaters are disposed in the formation for each production well.~~

5197. (previously presented): The method of claim 5196, wherein the part of the formation comprises a selected section.

5198. (currently amended): The method of claim 5196, wherein allowing the heat ~~is allowed~~ to transfer from one or more of the heaters ~~to at least a portion of the part of the formation to establish~~ establishes a pyrolysis zone in the part of the formation.

5199. (currently amended): The method of claim 5196, wherein allowing the heat ~~is allowed~~ to transfer from one or more of the heaters ~~to at least a portion of the part of the formation to establish~~ establishes a pyrolysis zone proximate to and/or surrounding at least one of the one or more heaters in the part of the formation.

5200. (previously presented): The method of claim 5196, wherein at least one of the one or more heaters is disposed in an open heater well.

5201. (previously presented): The method of claim 5196, wherein at least one of the one or more heaters comprises a natural distributed combustor.

5202. (previously presented): The method of claim 5196, wherein the produced mixture comprises condensable hydrocarbons having an API gravity of at least about 25°.

5203. (currently amended): The method of claim 5196, further comprising controlling a pressure and a temperature ~~within-in~~ at least a majority of the part of the formation, wherein the pressure is controlled as a function of temperature, or the temperature is controlled as a function of pressure.

5204. (previously presented): The method of claim 5196, wherein allowing the heat to transfer increases a permeability of a majority of the part of the formation such that the permeability of the majority of the part is substantially uniform.

5205. (currently amended): The method of claim 5196, wherein providing heat from the one or more heaters to at least the portion of the formation comprises:

heating a selected volume (V) of the coal formation from the one or more heaters, wherein the formation has an average heat capacity (C_v), and wherein the heating pyrolyzes at least some hydrocarbons ~~within-in~~ the selected volume of the formation; and

wherein heating energy/day (Pwr) provided to the selected volume is equal to or less than $h \cdot V \cdot C_v \cdot \rho_B$, wherein ρ_B is formation bulk density, and wherein heating rate (h) is about 10 °C/day.

5206. (new): The method of claim 2424, further comprising providing H_2 to at least a portion of the formation.

5207. (new): The method of claim 2424, further comprising providing H₂ to at least a portion of the formation to hydrogenate hydrocarbons.

5208. (new): The method of claim 5154, further comprising controlling the heat such that the mixture is produced from the formation as a vapor.

5209. (new): The method of claim 5154, further comprising providing H₂ to at least a portion of the formation.

5210. (new): The method of claim 5154, further comprising providing H₂ to at least a portion of the formation to hydrogenate hydrocarbons.

5211. (new): The method of claim 5196, further comprising providing H₂ to at least a portion of the formation.

5212. (new): The method of claim 5196, further comprising providing H₂ to at least a portion of the formation to hydrogenate hydrocarbons.
